Dissertation on

EFFECT OF CATARACT SURGERY (PHACO AND MANUAL SMALL INCISION CATARACT SURGERY) ON THE CORNEAL ENDOTHELIUM - A COMPARATIVE STUDY

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CERTIFICATE

This is to certify that this dissertation in **"EFFECT OF CATARACT SURGERY (PHACO AND MANUAL SICS) ON THE CORNEAL ENDOTHELIUM - A COMPARATIVE STUDY"** is a work done by **Dr.P.GEETHA,** under my guidance during the period 2005 - 2007. This has been submitted in partial fulfillment of the award of M.S. Degree in Ophthalmology, (Branch - III) by the Tamil Nadu Dr.M.G.R. Medical University, Chennai - 600 032.

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CONTENTS

INTRODUCTION

Over the years from Susruta's couching to Charles. D. Kelman's Phacoemulsification, cataract surgery has witnessed a phenomenal progress.

The successful cataract surgery is determined by the best and the earliest possible visual rehabilitation. Introduction of phacoemulsification by Kelman and no - stich surgery by McFarland are the major advances in reduction of destruction of the endothelium and quick visual rehabilitation.

Charles D. Kelman the pioneer in phaco surgery has written in one of his books "Those of us who perform the technique become enamored of the procedure, elated by the white, quiet post of eyes, proud of the work as an artist is proud of his and empathetic with the patient who back at work the next day proclaim that he had a cataract removed the day before and has no physical limitation". It seem we are now very close to ideal cataract surgery - our ultimate goal.

Successful cataract surgery depends on the good endothelial count pre operatively and post operatively. This observation of corneal endothelium by specular reflection date back to the early past of 20th century by Vogt demonstrated the first direct visualisation of corneal endothelial cells using principle of specular microscopy in 1918 using S/L bio microscope. We hope that this corneal endothelial study helps us to chose an ideal technique for extraction of cataractous lens in order to get a good visual rehabilitation in immediate post operative period as mentioned by our pioneer - our ultimate goal.

Cornea provides 75% of the refractive power of the eye and corneal transparency is required for clear vision. The corneal endothelium is a single cell layer lining the inner surface of cornea and plays an important role in corneal deturgescence.

The normal cornea at birth has a high endothelial cell density. The range of cell counts for individuals 40 - 90 years of age is 1500 - 3500 cells // mm^2. ***The purpose of study is to ascertain whether there is any alteration in endothelial counts by various techniques of cataract surgery.***

REVIEW OF LITERATURE

MILESTTONES IN THE HISTORY OF CATARACT SURGERY

1000 BC	:	Susruta, in India, practised `couching
1745	:	Daniel attempted first cataract extraction using lower limbal section with a triangular knife. He is a father of modern cataract surgery.
1773	:	Sharp advocated ICCE for first time. He achieved this by thumb pressure after the incision.
1865	:	Von Grafe designed cataract knife, made section in the upper half of limbus, advocated iridectomy.
1902	:	Stoever extracted the lens by pneumatic suction
1917	:	Barraquer extracted lens using suction apparatus.
1920	:	Van Lint improved regional anaesthesia and akinesia
1929	:	O' Brien
1951	:	Ridley implanted acrylic lens behind the pupil
1959	:	Barraquer used α chymotrypsin for zonulolysis

1961	:	Krwawicz described cryoextractor
1967	:	Kelman - Phacoemulsification

MILESTONES IN THE HISTORY OF SPECULAR MICROSCOPY

1918	:	Vogt demonstrated first direct visualization of corneal endothelial cells using principle of specular microscopy using a S/L microscope
1968	:	David maurice modified the metallergic microscope and obtained specular reflection from endothelial surface of excised corneas through a fluid medium at high magnification.
1975	:	Lating et al., did a modification of specular microscopy.

BOUNE et al., Clinical specular microscopy to study corneal endothelium.

Current wide field specular microscope has a view of 1mm^2 when compared to the initial specular microscope with a field of view of only 0.4 mm.

SELF SEALING CATARACT INCISION MILESTONES

Kratz	:	First surgeon to move from the limbus posteriorly to the sclera increasing appositional surfaces to enhance wound healing and attempted to exert less traction on cornea.
Girard and Hoffman	:	To call posterior incision a scleral tunnel incision.
Sheperd	:	Introduced single horizontal suture for closure of 4 mm scleral tunnel incision in phaco.
Mcfarland and ernest	:	No suture cataract surgery
Paul Koch	:	Incision tunnel

ANATOMY OF THE CORNEA

The cornea forms the anterior one fifth of the eyeball. It is elliptical being 12 mm in the horizontal meridian and 11 mm in the vertical. Ideally it forms part of the circumference of the sphere, but it is more curved in one meridian than other giving rise of astigmatism.

The radius of curvature of anterior surface is 7.8 mm and that of posterior surface is 7 mm. These radii hold good only for the central third of the optical zone. The cornea consists of five layers. The epithelium, Bowman's membrane, substantia propria, descemet's membrane and endothelium.

EPITHELIUM

The corneal epithelium is the contribution of the conjunctiva forwards. It is 50 - 100 μ in thickness and consists of five - six layers of non keratinizing stratified squamous epithelium starting from posterior to anterior, they are basal columnar cell layer wing or umbrella cell layer, two layer of polyhedral cells and layer of prickle cells.

BOWMAN'S MEMBRANE

It is not a basement membrane, but it is the modified anterior layer of stroma. It is 12 μ in thickness and is placed between epithelium and substantia propria. It does no regenerate once it is destroyed, but it is resistant to injury or infection. The collagen fibrils in this layer are smaller, more loosely packed and more randomly arranged than the corneal stroma.

CORNEAL STROMA OR SUBSTANTIA PROPRIA

This is a modified connective tissue, with a homogenous refractive index. It comprises 90 percent of corneal thickness and consists of multiple lamellae of collagen fibrils that are surrounded by mucopolysaccharide ground substance. The stromal cells called keratocytes are fibroblasts. The corneal stroma is totally avascular and it contains abundant non - myelinated nerve fibres.

DESCEMETS MEMBRANE

Descemets membrane is a true basement membrane produced by corneal endothelium. It is a strong structureless and resistant membrane measuring 6μ in thickness. It terminates peripherally at the schwalbe's line forming the anterior. border of trabecular meshwork. It can regenerate following trauma.

ENDOTHELIUM

The most posterior layer of the cornea, consists of single layer of flattened cells, continuous around the angle of anterior chamber with those on the front of the iris. Endothelium consists of ~ 500,000 metabolically active cells of mesothelial cell origin lining the posterior surface of descemet's membrane, facing the aqueous humor. These cells have limited ability to divide, so that with age, the number of cells is reduced. The remaining cells enlarge to fill the defects left by the dying cells. Therfore these hexagonal cells vary in diameter from 18-20 μ early in life to 40μ or larger in the aged. Endothelial cells are attached to DM by hemidesmones and laterally to each other by complicated interdigitating desmosomal linkages and zonulae occludentes adjacent to the anterior chamber. This linkage is calcium dependant and is important in maintaining the barrier function of endothelium.

The cytoplasm is rich is mitochondia which indicates active transport, secretion, and protein synthesis. The endothelium contains more mitochondria, than any other cells in the eye.

HASSAL HENLE BODIES

These are localised nodular thickenings appearing in the peripheral area, disturbing the regular mosaic of endothelial cells. They appear as small, round, dark areas within the normal endothelial mosaic. These thickenings are due to over production of hyaline by endothelial cells. As the number of H-H bodies increase, the endothelial pump density also increases to enhance pump function.

Embryologically, the cornea is the continuation of three structures.

a. The epithelium and bowmans membrane of the conjunctiva

b. The substantia propria of the sclera.

c. Descemet's membrane and posterior endothelium of the uveal tract.

PHYSIOLOGY OF THE CORNEA

The cornea, the most important refractive medium of the eye is characterised by a high degree of transparency. This is due to factors like the regularity of the anterior epithelial surface and overlying tear film, the regular organisation of stromal collagen, the absence of blood vessels and the paucity of cells.

FACTORS AFFECTING CORNEAL HYDRATION

Stromal Swelling Pressure

Swelling of the cornea and its increase in thickness are due to glycoso aminoglycans which are present in the interfibrillar space of stroma. The swelling pressure of normal excised cornea is 50 mmHg. This is a negative pressure, because the presumed glycosoaminoglycans anionic repulsion expands the tissue, sucking in the fluid with equal but negative pressure called imbibition pressure. In vivo imbibition pressure is lower than the SP, the difference being equal to intraocular pressure.

$$IP = IOP - SP$$

BARRIER FUNCTION OF THE LIMITING LAYERS

Both the epithelium and endothelium act as semi permeable membranes that create a barrier to the diffusion of electrolytes to the flow of water. The epithelium offers the high resistance to Ionic flow and the barrier function of endothelium is ca dependent.

ACTIVE HYDRATION CONTROL

The maintenance of corneal thickness is related to corneal metabolism. The cornea will thicken if the enucleated eye is cooled to O° centrigrade. On subsequent warming to 37°C it will reverse to its original thickness. This "temperature reversal" of hydration require oxygen, the site of this active dehydration process in the human is the endothelium.

Corneal swelling occuring in the absence of epithelium is due to loss of barrier function. Oxygen deprivation and metabolic inhibition of the endothelium causes corneal swelling. The endothelial pump is dependent on oxygen, glucose and carbohydrate metabolism, that is pyruvate, lactate and other Kreb's cycle substitutes producing ATP, which release high energy phosphates by ATP are to supply energy for the system.

Evaporation causes about 4% thinning of cornea, as a result of osmotic extraction of fluid due to tears made hypertonic by evaporation.

INTRAOCULAR PRESSURE

With normal IOP there is no effect upon corneal thickness. However IOP is related to epithelial edema of cornea. When the imbibition pressure becomes positive that is when the IOP exceeds the swelling pressure, epithelial edema will occur. This can take place with a high IOP and normal stromal swelling pressure and thickness as is acute glaucoma with normal IOP and low stromal swelling pressure as in corneal edema, secondary to endothelial dystrophy.

CORNEAL BIOCHEMISTRY

Biochemical concentration of electrotytes are dependent upon the state of corneal hydration. The concentration of sodium is high in stroma and epithelium is rich in potassium.

EPITHELIUM

Water in the epithelium represents 70% the wet weight and nitrogen 11.9% of the dry weight. Total lipids 5.4% of dry weight of epithelium and there is total abence of collagen. These is a high level of enzymes necessary for the Embden - Mayerhoff and pentose shunt pathways of glucose metabolism and also the Kreb's cycle for oxidation of pyruvic acid.

STROMA

It contains 75 - 80% of water and the remaining solids are mainly collagen and glycosoaminoglycans.

SOLUBLE PROTEINS

The amount to 25% of dry weight include albumin, immunoglobulins and glycoproteins IgA and IgG are present in equal concentration.

Highest concentration of glycosoaminoglycans is present in the stroma and they comprise keratan sulphate, chondroitin sulphate and chondroitin. Glycosoaminoglycans account for the swelling pressure of the stroma i.e., its tendency to imbibe water.

Descemet's membrane mainly contains collagen which is about 73% and glycosoaminoglycans is absent.

ENDOTHELIUM

All the enzymes necessary for Embden - Mayerhoff and HMP pathways and those needed in Kreb's cycle are present in the endothelium.

CORNEAL METABOLISM

Cornea obtains most of its energy requirements by oxidising glucose. The rate of oxygen consumption is from 0.8 - 1.0 µl/hr/mg of dry tissue. Epithelium derives oxygen from atmosphere across the tears and from the limbal capillaries whereas the endothelium depends upon oxygen from the anterior chamber. The rate of glucose consumption by the whole cornea is 100 $\mu g/hr/cm^2$, and ninety percent of this is consumed by the epithelium. Through glycolysis the mole of glucose is converted to two moles of pyruvic acid and results in two moles of ATP being produced. The utilization of pyruvic acid in the TCA cycle results in the formation of 36 moles of ATP per one mole of glucose.

SUPPLY OF GLUCOSE

The limbal vessels supply 20% of the needs of the cornea and the peripheral 1 - 2 mm. Major supply of glucose to all layers is through aqueous humor. Glycogen which is present only in epilthelium, acts a reserve energy source especially after injury or trauma.

OPTICAL PROPERTIES OF CORNEA

The majority of optical focusing power of the eye is in the cornea. The cornea's structural properties therefore must fulfill the same criteria as any lens in an optical focusing system.

1. A smooth surface, 2. Sphericity, 3. Internal transparency.

Although the cornea as a whole is an aspherical surface, the central cornea is nearly spherical and two primary areas of differing spherical power can be identified.

Three optical zones are present

1. A spherical central optical zone 3 - 4 mm.
2. An aspherical, less steep, mid peripheral zone (5.0 - 7.0 mm)
3. A still flatter limbal zone.

FUNCTIONS OF THE ENDOTHELIUM

Corneal endothelium plays a very important role in maintaining corneal transparency. It maintains the normal corneal thickness by means of its deturgescence function. Corneal thickness is directly related to the health of endothelium.

THE PHYSICS OF PHACO

Overview

A sophisticated transducer changes electrical to mechanical energy, accelerating a needle to 250,000 G's over a stroke of 3 mils at 54,000 strokes / sec. and allows the surgeon to overcome the inertia of nucleus and emulsify it.

PHACODYNAMICS

Phaco Power : Is the ability of the phaco hand piece to cut or emulsify the cataract. Phaco power is directly related to stroke length, frequency and efficiency of hand piece.

Stroke length : It is the distance by which the titanium phacotip moves to and fro. It is the most important factor in deciding the phaco power.

Frequency : Is the number of times the tip moves and is fixed for a particular phaco hand piece. It is measured in KHZ.

CONSTANT Vs PULSE

Phaco Power : In constant mode, power is delivered continuously and it can be linear or panel controlled. Pulse mode allows phaco power to be delivered at preset intervals which can be varied.

MAXIMUM PHACO POWER

It is preset by surgeon. It determines maximum obtainable Ultrasonic energy when foot pedal is fully depressed.

ACTUAL PHACO POWER

Is proportional to foot pedal position and denotes the power actually being delivered at a given time.

EFFECTIVE PHACO TIME

Is the total phaco time at 100% phaco power.

IRRIGATION AND ASPIRATION SYSTEMS

Irrigation variables

1. Bottle height is 22 - 30 inches above eye

2. Inflow port is fixed at 1 mm.

ASPIRATION VARIABLES

1. Aspiration rate - defined as how fast vaccumn is created when aspiration tip is occluded or volume of fluid aspirated / unit time.

2. Aspiration level - how much vaccumn is generated when aspiration tip is occluded

3. Aspiration pump types

   (a) peristaltic pump - Rotating can creates vaccum by sequentially compressing plastic tubing.

   Aspiration rate (flow) and aspiration level (vaccum) are independent and variable.

   In a peristaltic pump, no vacumn is created until the aspiration port is occluded.

   Once occluded, the development of vaccum to the preset level is usually slower.

   - Increasing depression of the foot pedal increases speed of peristatic pump.

b. Diaphragmatic pump - Vacumn pump creates vaccumn

   - Aspiration level (vaccum) is fixed with relationship to flow.

- Occulsion of aspiration port is not necessary to create vaccum.

- Increasing depression of the foot pedal increases the amount of vaccum.

- The rate of development of vaccum is rapid.

c. Venturi pump - Compressed air passing through venturi tube creates vaccum.

- Exquisite control of vaccum level

- Rapid development of vaccum.

FOOT PEDAL

* There are four position in phaco mode designated 0, 1, 2 and 3.

* Position `O' refers to resting, fully upright point of foot pedal. The other three position 1, 2 and 3 refer to the range of foot pedal travel.

* In position 1, irrigation is present.

* In position 2, irrigation and aspiration are present.

* In position 3, irrigation, aspiration and phaco power are present.

PHACO VARIABLES

PUMP FLOW

Is a measure of the rotational speed of the peristaltic pump head, which determines the flow rate of aspiration. This pump flow or aspiration rate is preset by surgeon.

MAXIMUM VACCUMN

Is the level that is preset by the surgeon. It represents highest vaccum obtainable during complete occulsion of the aspiration port - Typical settings are 65 to 75 mmHg for phaco probe and 360 mmHg for IA probe.

ACTUAL VACCUM

Indicates real time vaccumn pressure at the aspiration port, which depends on the position of foot pedal, maximum preset pump flow, degree of tip occlusion.

FLUIDICS OF PHACO SURGERY

Four components of fluidics are

1. Inflow 2. Aspiration 3. Vaccum 4. Energy

All the above four have their definite role and comprises the PHACO DYNAMICS.

1. Fluid in (Infusion flow)

This is the rate of fluid entering the eye. This maintains the intraocular pressure, removes the particles and cools the hand piece. The fluid enters the eye from a bottle suspended at 65 cms above patients head.

2. Fluid out

This may be because it leaks out or is pumped out.

A. Fluid by leakage

This occurs either at the main incision site or at the side port. The leakage depends on wound size, configuration and how it is hold closed by instruments.

B. Fluid by pump action

The aspirate rate is the rate at which fluid is pulled out by the pump action. Aspiration flow rate controls the ability of the materials to move towards the phaco tip. This is called follow ability.

3. Vaccumn

This is the negative pressure generated at the phaco tip and is measured in mmHg.

Rise Time

This is the time taken for the vaccum to reach the preset level once the occlusion occurs.

4. Phaco Energy

This is measured in Joules and is caused by tip vibration and cavitation. As the tip vibrates it acts as mini jack hammer. The ability of phaco energy to destroy the cataract depends on :

a. Direct impact of tip on the lens at the end of its stroke.

b. Cavitation - It is the process by which heat energy causes tiny bubbles to implode among themselves creating an energy wave which destroys the solid material of cataract.

c. Acoustic wave delivered through the fluid from the tip.

d. Impact of fluid and lens particles pushed forward in front of the tip with velocity upto 72 km/hr.

CONTROLLING FACTORS FOR SURGICAL OBJECTIVES

1. Stable Anterior chamber depth and intra ocular pr

Height of irrigation bottle, control of leakage, aspiration flow rate, anti surge mechanism

2. Followability

Control of aspiration flow rate.

3. Holdability

Control of vaccum

4. Release of materials from tip

Venting mechanism

5. Emulsification

Phaco energy, frequency, design of the tip.

MANUAL SMALL INCISION CATARACT SURGERY (MANUAL PHACO)

In manual small incision cataract surgery, through a scleral tunnel incision the nucleum is hydrodissected into the anterior chamber and then manually removed.

INDICATION

Manual small incision cataract surgery is universally applicable to nearly all cataract extracting procedures.

CONTRA - INDICATIONS

The C.Indications to non phaco small incision surgery are mainly relative since it can be performed in most cases once a degree of expertise is achieved.

Absolute	Relative
Post inflammatory limbal area	Black cataracts,
subluxated / dislocated lens	Brown cataract,
severe congenital anomalies	Deep sockets,
	Small hyperopic,
	Small pupil.

STEPS IN SMALL INCISION CATARACT SURGERY

Wound Architecture

CCC

Hydrosurgeries

Nuclear management

I /A

Lens insertion

Sutureless closure

WOUND ARCHITECTURE

A scleral tunnel incision has got 3 components.

a. External Scleral incision

After making a fornix based conjunctival flap a light cautery is applied. A half thickness perpendicular external scleral groove is fastioned with either B - P knife or crescent knife. The groove is located 2.5 - 3 mm from the surgical limbus and could be limbus parallel, linear or frown shaped. Linear incision was adopted for this study.

b. Sclerocorneal tunnel

The horizontal tunnel is dissected with a bevel up crescent blade parallel to the sclera, splitting its lamellae along its entire length. It is extended upto 1 - 1.5 mm into clear cornea. Care should be taken not to button hole the scleral flap or enter the ant chamber prematurely.

c. Internal corneal incision

This is a created using a sharp 3.2 mm angled keratome The heel of keratome is raised till the blade becomes parallel to the iris plane and the keratome tip creates a dimple on the cornea. Next the heratome is advanced anteriorly in the same plane till the AC is entered and the internal wound is visualised as a straight line. This incision may be extended at the conclusion of surgery to the desired length which is predominantly governed by the optic size of the IOL to be inserted.

OPTIMUM INCISION ARCHITECTURE

The scleral tunnel incision may be considered to have 3 dimensions.

1. The thickness of the flap

2. Width : The perpendicular distance from the scleral groove to the line of entry into Anterior chamber.

3. Length : The distance between the ends of the incision.

Flap thickness

The optimum incision depth may be between one third - one half the thickness of sclera.

WIDTH

Incision width is determined by the location of the external wound and the internal corneal wound relative to limbus. Incision width should be equal to incision length and the ideal amount of dissection into clear cornea is 1.5 mm. "Astigmatism neutral" produced by posterior external incision.

MECHANICS OF CAPSULORHEXIS

Continuous curvilinear capsulorhexis (CCC) was first produced by Gimbel and Neuhann.

Advantage

1. Prevents post op. iris contact.

2. Prevents the development of posterior. synechiae.

3. Improved IOL centration within the bag.

4. Decrease the rate of posterior capsule opacification.

5. In posterior capsular rupture (PCR) IOL is placed in sulcus.

6. Provides a safe method of IOL implantation in patients with uveitis.

7. Allows endolentiular phacoemulsification to be performed through a small aperture.

The tear is begun at the center of anterior capsule. Basically two ways to tear a planar material.

TEARING BY STRETCHING

The force is in the plane of maximum resistance of the material. Force must be directed perpendicular to the desired duration of tearing. Once started this type of tear will proceed very rapidly and can easily get out of control.

TEARING BY SHEARING

The force is in the plane of the least resistance of the material. Force must be directed parallel to the desired direction of tearing. Once started, this type of tear will proceed slowly, and can easily be controlled and so is the preferred method. Tearing by shearing was adopted for this study.

SIZE OF THE CAPSULORHEXIS

Endolenticular phacoemulisification is actually easier to do through a small capsulorhexis (4 - 5 mm) because, after hydrodissection, the small ccc holds the nucleus in position better for sculpting and nuclear rotation and also reduces the risk of iris entrapment in the phaco tip.

HYDRO PROEDURES

They include primarily hydrodissection and hydrodelineation. Of paramount importance to this technique is the mobility of entire lens complex within the capsule. This is accomplished via Hydro dissection. The goal of hydro delineation is to seperate the endonuleus physically from the epinucleus.

HYDRODISSECTION

The term was introduced by FAUST the essential prerequisite for hydro dissection is a clean capsulorhexis.

Method

The size of ccc should be assured 4 to 4.5 mm. The anterior capsule is elevated with a blunt cannula to form a tent. The fluid is injected underneath the anterior capsule near the equator. This separates the cortex from capsule and from epinucleus.

Hydrodelineation

This was advocated by ANIS. Fluid is directly injected into lens matter which confines of the bag which allows nucleus to be broken into layers.

Method

A 26 g cannula is introduced between the central core nucleus and epinucleus. The cannula is placed tangentially into the epinucleus and the fluid is injected. The result is golden ring or Dark halo which is created by light reflex around lens border. This should be a complete ring.

Keeps the posterior capsule safe. Also stretches the capular bag.

PHACOEMULSIFICATION PROCESS

ENDOLENTICULAR PHACOEMULSIFICATION

Endolenticular phacoemulsification or In situ phacoemulsification refers to the procedure that takes place basically with in the confines of capsular bag through a fairly large, centrally placed continuous tear capsulotomy.

In this technique, the majority of phacoemulsification is done deep to pupillary plane using low, linear power.

Removal of endonucleus can be done with either non - cracking or cracking techniques.

Non cracking technique

a. Chip and flip technique

b. Sequential pulsed removal of inner nuclear girdle.

Cracking methods

a. Gimbel's trench and crater nucleo fracture method (followed in this study).

It is a modification of the fourquadrant cracking method originally described by John Shepherd.

As the endo nucleus is exposed the initial step involves making a central groove through the nucleus. Once approximate depth is obtained the nucleus is broken into two halves using a sinskey hook and the endonucleus split into two halves.

A second groove is made in the centre of this endonuclear half in preparation of splitting it into quarters.

Once the quarters are free, using both the phaco emulsification tip and second instrument, each quarter is serially grasped and brought into the central safe zones. Utilising very short, intermittent bursts of phaco power each quarter can be efficiently removed.

b. Stop and chop technique (Paul Koch)

In the stop and chop technique, like the four quadrant technique, the initial trench is made towards 6'0 clock. With the help of chopper the nucleus is split into two halves. Each nuclear half is chopped up into multiple small pieces which become much more manageable with gentle emulsification using mere vaccumn and minimum placo power.

NUCLEAR MANAGEMENT IN MANUAL SICS SURGERY

Techniques : The nucleus is hydrodissected into the anterior chamber and then extracted out by using any of the following techniques.

HYDRO EXTRACTION BY IRRIGATING VECTIS

Under cover of viscoelastics the nucleus is hydroextracted out of the AC with the aid of irrigating vectis. This technique was followed in this study.

Other techniques

Phacosandwich technique

Phacofracture technique

Nuclear division by wire loop

Mininucleus technique

Cortical wash and IOL implantation

The residual cortical material is removed using a simcoe cannula or I/A handpiece. The IOL is inserted into the bag.

SPECULAR MICROSCOPY

USING A NARROW SLIT OF LIGHT

When a narrow slit of light is focussed on to the endothelial cell - aqueous humor interface, considerable amount of light is reflected specularly back towards the film by Lens coupling fluid interface.

Coupling fluid - Epithelium interface

Endothelium - Aqueous humor interface

At the film plane light from various regions overlap.

FOUR ZONES ALL DESCRIBED

Zone I - Bright region - By light reflected from the lens coupling fluid and coupling fluid epithelium interface or both.

Zone II - Shows posterior of stroma

Zone III - Shows endothelial layer

Zone IV - Shows part of aqueous region.

Interface between zones III and IV is called the dark boundary.

Interface between zones II and III is called bright boundary. It separate the endothelial reflection from overlying illuminated corneal tissue.

Using a wide slit of light

A larger field of view of endothelial cells result but a wider beam illuminates more of corneal tissue anterior to endothelium. So greater number of cells visible with a wider slit is obtained masking the abnormalities of corneal stroma.

Types of specular microscopes

1. **Clinical specular microscopies**

    a. Contact wide field - Better resolution and image quality

    b. Non contact wide field

2. **Eye bank specular microscope**

3. **Slit lamp attached**

TECHNIQUES OF SPECULAR MICROSCOPY

Basic technique is to align the instrument to the patients eye, so that the conditions for specular imaging are obtained.

The endothelium being observed must be at the correct distance from objective lens. So that the image is in focus on the focus plane of specular microscope.

For non contact specular microscope, region of endothelium perpendicular to the line bisecting the optic axis of the illuminating objective and optic axis of light collecting objective.

INDICATIONS FOR SPECULAR MICROSCOPY

1. Endothelial count in cataract surgery
2. Previous trauma
3. PXF
4. Clear graft with operable cataract
5. Coneal edema in C/L eye
6. Fuch's endothelial dystrophy
7. Posterior polymorphous dystrophy

8. Effect of various irrigating solution and intra cameral products used during cataract on endothelium.

9. Different technique of cataract surgery, related instruments and endothelial response.

10. Evaluation of donor endothelium

11. In various refractive procedures

12. C/L wearers and phakic IOLS.

METHODS OF EVALUATION OF CORNEAL ENDOTHELIUM

1. Quantitative assessment

2. Qualitative assessment

INSRUMENTATION

Topcon specular microscope is a complete design with a built in high resolution camera that gives high quality images. A built in cell analysis system allows rapid and accurate cell count as well as parameters such as polymegathism and pleomorphism.

The built in pachymeter will provide the capability of measuring corneal thickness. Four important parameters for assessing the state of cornea are :

1. Cell density

2. Cell size variation

3. Cell shape variation

4. Corneal thickness

QUANTITATIVE ANALYSIS

Cell density : A high 1% of hexgonal cells and an absence of polymegathism imply a stable endothelial damage.

Normal density	4500 - 1500	At birth (3000-4000
Low	1000 - 1500	cells/mm^2)
Borderline	500 - 1000	> 40 years (2500 - 2700
< 500	Usually edema	cells /mm^2)
Mean cell size (cell area)	150 - 350 μm^2	

QUANTITATIVE ANALYSIS

a. Fixed frame analysis of cell size counts the number of cells within a frame and constant area.

b. Variable frame anlaysis

Computer based analysis has less counting error.

Atleast 30 - 50 cells should be counted to be accurate.

PARAMETERS OBTAINED

a. CELL DENSITY

Cell density is an inversion of cell area i.e. 100,000 divided by average cell area given in cells / mm^2.

b. CV - CO-EFFICIENT OF VARIATION

Calculated as standard deviation (SD) divided by average cell area and therefore larger the CV, there is a wide variety in cell sizes. The normal range is 0.2 - 0.3. Lower CV more stable the cornea.

c. POLYMEGATHISM

Polymegathism is increased variation in individual cells areas.

$$\text{\% of hexagonal cells} = \frac{\text{No. of hexagonal cells}}{\text{No. of cells entered}}$$

Significant polymegathism - > 0.4 might not tolerate surgery.

d. PLEOMORPHISM

Pleomorphism : Increased variability in cell shape.

Corneas with high pleomorphism greater than 50%. Might not tolerate intraocular surgery.

e. CORNEAL THICKNESS

Corneal thickness

Normal thickness of central cornea is 0.51-0.52 mm

Normal thickness of peripheral cornea is 0.75-0.85mm.

FACTORS AFFECTING ENDOTHELIAL COUNT INCLUDES

1. Intra operative and post op complications.
2. Mechanical injury caused by AC instrumentation
3. Ac manipulation of hard lens nucleus
4. Ultrasonic vibration
5. Heat generated by ulrasonic tip
6. Prolonged intraocular irrigation
7. Inadequate use of viscoelastics
8. Momentary contact between IOL and corneal endothelium
9. Turbulence of fluids in AC
10. Phaco power
11. Pre op status of endothelium
12. Small pupil diameter

Other Causes

1. Increase IOP in glaucoma
2. PKP
3. Epithelialization of AC
4. Vitreous contact with endothelium
5. Blunt trauma
6. C/L wear
7. Diabetes Mellitus
8. Ref. Surgery
9. Aging
10. Fuch's
11. PPD
12. Keratoconus

AIM OF THE STUDY

To compare the effect of phacoemulsification cataract surgery and manual small incision cataract surgery on the corneal endothelial cell count.

MATERIALS AND METHODS

A prospective study was carried out on 100 patients who underwent cataract surgery by manual SICS and phaco at the Regional Institute of Ophthalmology and Govt. Ophthalamic Hospital, Chennai during the period from August 2005 to August 2006. Surgeries done by a single surgeon is taken for the study.

INCLUSION CRITERIA

1. Senile cortical cataract and nuclear cataract.
2. Age between 30 - 70 years.

EXCLUSION CRITERIA

1. Preexisting corneal diseases
2. Complicated cataract
3. Cataract associated with glaucoma
4. Detectable posterior segment lesions
5. Systemic illness
6. Irregular follow up

PRE-OPERATIVE EVALUATION OF PATIENTS

This included detailed history taking and routine investigations for IOL surgery like :

- Recording of BCVA with snellens or E-chart
- Recording tension with schiotz tonometer
- Assessing the patency of duct
- K-reading measurement using Bausch and Lomb Keratometer
- A scan and IOL power calculation using SRK-II formula.
- Slit lamp examination for grading of nucleus and anterior segment evaluation
- Cell density of endothelium evaluated using Topcon non contact specular microscope
- Necessary parameters for systemic profile (Diabetes mellitus and Hypertension).
- Evaluation of status of other eye.

SURGICAL DETAILS

Preoperatively adequate mydriasis was achieved with application of tropicamide and 10% phenylephrine three times, one hour prior to surgery. Peribulbar anaesthesia was used in all cases. Ocular hypotony was achieved with digital compression.

The external incision was made about 2 mm from limbus with No.11 blade and was shaped either linear or frown. A 5.5 mm (for phaco) or 6 mm (manual SICS) long incision with sclero - corneal tunnel and self sealing corneal valve was fashioned after making a fornix based conjunctival flap. Tunnel was created with crescent blade upto 1.5 mm into clear comea. Entry into AC was made with 3.2 mm keratome and later extended.

MANUAL SMALL INCISION CATARACT SURGERY

A can opener capsulotomy or continuous curvilinear capsulorhexis was performed with a 26 g needle cystitome depending on cataract type and pupillary mydriasis.

The nucleus was prolapsed into AC using hydro dissection and hydraulic expression and then was removed with irrigating vectis. All manipulation was carried out under cover of viscoelastics.

Cortex was aspirated with simcoe cannula. Single piece PMMA 6 mm optic IOL was inserted through the tunnel into capsular bag and properly centered. Anterior chamber was formed and the wound allowed to self seal. Surgery was concluded with a sub conjunctional injection of Dexamethasone 4 mg after repositioning conjunctiva over the wound.

PHACO SURGERY

After entry into AC with 3.2 mm keratome phaco probe was introduced into AC and was guided into lens susbtance. For soft cataracts phaco aspiration was done and in other nucleus was emulsified using divide and conquer technique. The phaco parameters were as follows;

Phaco	Power %	Vaccum (mm/Hg)	Flowrate (cc/mt)
Trenching	70-80	50	10-20
Quadrant emulsification	50-60	200	25-30

Cortical clean up was done followed by in the bag placement of phaco PMMA lens of 5.25 mm optic. Ac was formed and wound allowed to self seal. Surgery was completed with sub conjunctional injection of dexamethasone 4 mg.

Post operative mgt. and follow up

Patients received topical steroid antibiotic drops and cyclopentolate 1% eye drops.

Patients were subjected to specular microscopy on the 4th post operative day. The V/A was recorded. The corneal endothelial count was recorded. The findings were tabulated on a specially prepared proforma and various parameters were studied.

ANALYSIS AND DISCUSSIONS

100 patients were included in this study.

56 patients were females and 44 of them were males. Age of patients ranged from 30 - 70 years. The mean age of patents was 52.18 years.

Clinical hardness of lens nucleus was graded based on S/L evaluation of color of nucleus. They were graded as follows :

Grade	Colour of Nucleus	No. of Eyes	Percentage
Grade I	White or Green & Yellow	22	22%
Grade II	Yellow	44	44%
Grade III	Amber	22	22%
Grade IV	Brown	0	0%
MC	White	12	12%

50 patients who underwent manual SICS had superior scleral incision which was self sealing and sutureless and 50 patients who underwent phaco surgery few had supero temporal and few patients had supero nasal scleral incision.

PHACO SURGERY

50 patients underwent this surgery. 20 of them were males and 30 females. Age of patients ranged 30 - 70 years. Mean age was 52.18 years nuclear grading in this group was between Grade I - III and 2 of them had mature cataract.

Grade of mucleus	No. of Eyes	Percentage
Grade I	20	40%
Grade II	26	52%
Grade III	2	4%
MC	2	4%

Grade II cataract was commonest and was seen in 26 eyes (52%).

Incision was Linear and CCC was done in all cases.

PER OPERATIVE COMPLICATIONS

Complications	No. of Eyes	Percentage
Vitreous disturbance	5	10%
Increase irrigation	3	6%
Increase phaco time	3	6%

The commonest intra operative complication was PC rupture with an incidence of 10%. Endothelial cell count done using non contact specular microscopy and taking an average count of 30 cells in all eyes.

The endothelial count showed a loss of :

Endothelial cell count	**No. of eyes**	**Percentage**
< 100	23 eyes	46%
100 - 500	15	30%
500 - 1000	7	14%
> 1000	5	10%

The endothelial cell loss of 500 - 1000 and above were found to be due to the complications like PCR, increased phacotime and increased fluids in the AC (Prolonged irrigation).

The endothelial loss of < 100 cells were found in majority of eyes 46% who underwent phaco surgery.

BCVA ON 4th POST OPERATIVE DAY

BCVA	No. of eyes	Percentage
6/6	20	40%
6/9	16	32%
6/12	9	18%
6/18	5	10%

36 out of 50 eyes (72%) had vn 6/6 - 6/9 vision in patients who underwent phaco surgery in the immediate post of period (4th POD) and the `p' value for BCVA was not statistically significant.

MSICS (Manual Small Incision Cataract Surgery)

50 patients underwent this surgery 22 of them of were males and 28 of them females. Age of patients ranged from 35 - 70 years. Mean age was 55.58 years. Nuclear grading in this group was between I - III and 10 persons had MC.

Grade of nucleus	No. of Eyes	Percentage
I	2	4%
II	18	36%
III	20	40%
Mature cataract	10	20%

Grade III cataract was commonest and was seen in 20 eyes (40%)

All eyes had a linear incision and a continuous curvilinear capsulorhexis.

Per operative complications	No. of Eyes	Percentage
P.C.R.	2	4%
Premature entry	3	6%
Difficulty in delivering mucleus	2	4%

Endothelial cell count was done with the non contact specular microscopy taking an avg count of 30 cells in all eyes.

Endothelial cell count	No. of Eyes	Percentage
< 100	9	18%
100 - 500	23	46%
500 - 1000	13	26%
1000 - 1500	2	4%
> 1500	4	8%

Endothelial cells loss of 100 - 500 was found in 23 eyes (46%) who underwent Manual SICS tunnel surgery.

A cell loss of >1500 was found in 4 eyes (8%) who underwent non phaco cataract surgery and this incidence was very minimal with phaco surgery and the `p' value was statistically significant at 1% level (p value <0.001).

BCVA ON 4th POP DAY

BCVA	No. of Eyes	Percentage
6/9	8	16%
6/12	5	10%
6/18	17	35%
6/24	7	14%
6/36	5	10%
6/60	8	16%

30 out of 50 eyes had BCVA of 6/9 - 6/18 in patients who underwent manual SICS.

40% of patients who had a decreased vision of 6/24 - 6/60 recovered a vision of 6/6 and 6/9 after a few weeks post operatively. `p' value for BCVA was statistically significant at 1% level.

SUGGESTIONS

Comparison of similar grading of cataract by phaco and manual SICS and consistency in phaco time to be maintained for better comparison.

RESULTS

MANUAL SMALL INCISION CATARACT SURGERY

1. 20 eyes (40%) had grade III cataract which was the commonest type.

2. Among the per operative complications rupture of posterior capsule and premature entry was the commonest with an incidence of 4% and 6% respectively. The incidence of complication were higher as the grading of sclerosis increases.

3. Endothelial count loss of between 100 - 500 cells was higher with an incidence of 44% (22 eyes) and a count loss of > 1500 cells was also found with an incidence of 8% (4 eyes). Endothelial cell loss of < 100 was found to be 18% (9 eyes).

4. 30 out of 50 eyes (61%) had vision of 6/9 - 6/18.

PHACO SURGERY

1. The commonest type of nucleus was grade II with an incidence of 52% (26 eyes).

2. Among the frequent complications rupture of post capsule was found to be commonest with an incidence of 10% (5 eyes) due to

improper hydrodissection or when the grading of nuclear sclerosis increases.

3. Endothelial count loss of < 100 cells only was found to be highest with an incidence of 46% (23 eyes) and a loss of > 1500 was not made out in this study.

4. 36 out of 50 eyes (72%) had vision of 6/6 - 6/9.

(The difference in cell density preoperatively and postoperatively by specular microscopy between phaco and manual SICS was found to be statistically significant `p' value <0.018 (5% level).

STATISTICAL ANALYSIS

Out of 100 patients 50 patients underwent phaco and 50 patients underwent manual SICS surgery.

Group	CD - Difference between pre-operative and post-operative		`p' value
	Mean	SD	
Phaco	270.70	409.57	0.018*
MSICS	529.42	643.55	

* Denotes - Significant at 5% level.

Group	BCVA on 4th POP Day		`p' value
	Mean	SD	
Phaco	9.04	3.46	<0.001**
MSICS	25.32	16.96	

** Denotes - Significant at 1% level.

The effect of cataract surgery by manual SICS on endothelial cell loss was found to be statistically more significant when compared to phaco (p value < 0.001).

The effect of cataract surgery by phaco and manual SICS on endothelial cell loss carries a significant `p' value of 0.018.

Age Group	**Group**			
	Phaco		**MSICS**	
	Mean	**SD**	**Mean**	**SD**
< 50	157.29	364.29	338.55	461.32
50 - 60	301.63	401.71	673.44	758.74
> 60	452.83	539.88	421.21	501.45
`p' value	< 0.272		0.277	

`p' value was not significant based on age or sex on endothelial cell loss by the techniques of surgery carried out.

Reference :

p value $\leq$ 0.01 - Significant at 1% level

p value (0.011 to 0.05)* Significant at 5% level

p value (> 0.05) not significant at 5% level.

CONCLUSION

Endothelial cell count loss by this study was found to be less with phaco surgery than with manual SICS.

The endothelial cells loss attributed to the phaco surgery by this study was found to be mostly due to intra operative complication like post capsular rupture with vitreous disturbance, increased irrigation in the anterior chamber, increased phaco time in few cases and sometimes due to difficulty in IOL manipulation.

The optical property of the cornea can be maintained by protecting, endothelium by following a proper technique in all the steps right from the incision to implantation of IOL.

Phaco surgery was found to be superior to manual SICS by ensuring minimal injury to the endothelial cells and thus provides a good BCVA when compared to manual SICS immediately after the surgery thus providing a quicker visual recovery.

PROFORMA USED FOR THE STUDY
PHACO / MANUAL SICS

Case No. OD / OS

Name :

Age :

Sex :

Address :

No. :

Complaints

Defective Distant Vn
Defective Near Vn
Duration

History of any treatment / surgeries

Pre operative evaluation

V/A	RE	LE
V/A with PH		
V/A with PG		
Refraction		
Subjective		

Anterior segment examination	**Normal**		**If abnormal specify**	
	Y	**N**	**RE**	**LE**
Lids	-	-	-	-
Conj.	-	-	-	-
Cornea	-	-	-	-
Ac depth	-	-	-	-
Pupil	-	-	-	-

Lens Cortical Nuclear PSC

I, II, III IV

Fundus
Tension
Nasolacrimal duct
Pre op. Keratometry reading

Anaesthesia	Good	Fair	OK
Peribulbar			

Pupil dilatation	4 - 6	6 - 8	8 - 10 mm
Phaco			

Incision	Sup	:	Scleral
Type		:	Linear
Size			5 mm / 5 mm and more

Capsulorhexis

- Cystitome / Forceps
- Size

Phaco technique

4 - quadrant
Phaco aspiration

Phaco Power				
Phaco time				
Irrigation fluid	Type			
	Amount			
IOL	Type			
	Size			
	Model			
Manual SICS				
Incision	Type	Sup	:	Scleral / Linear
	Size			
Capsular Surgery	Capsulorhexis			

IOL details :

Complications

Per operative

Specular Microscopy (4th POD)

Endothelial Count (Cell density)

Preoperative	Post Operative

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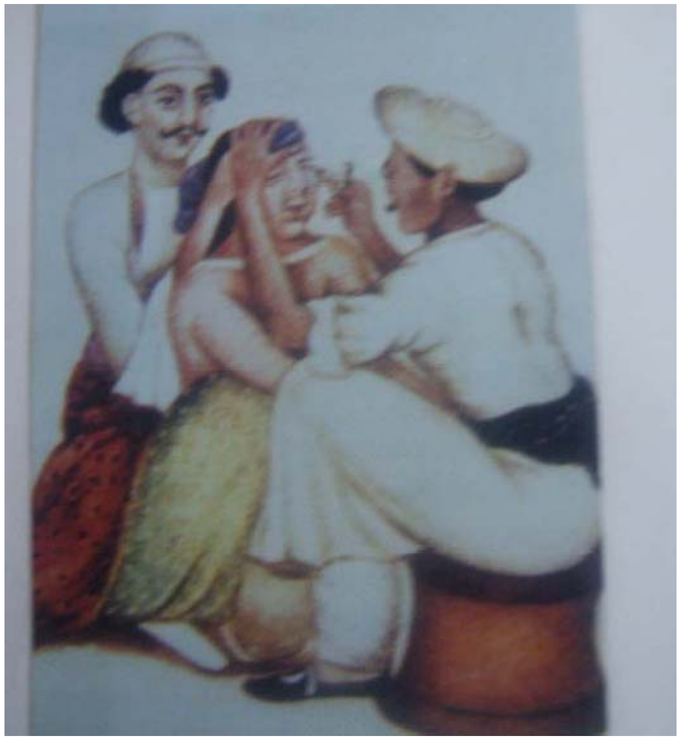
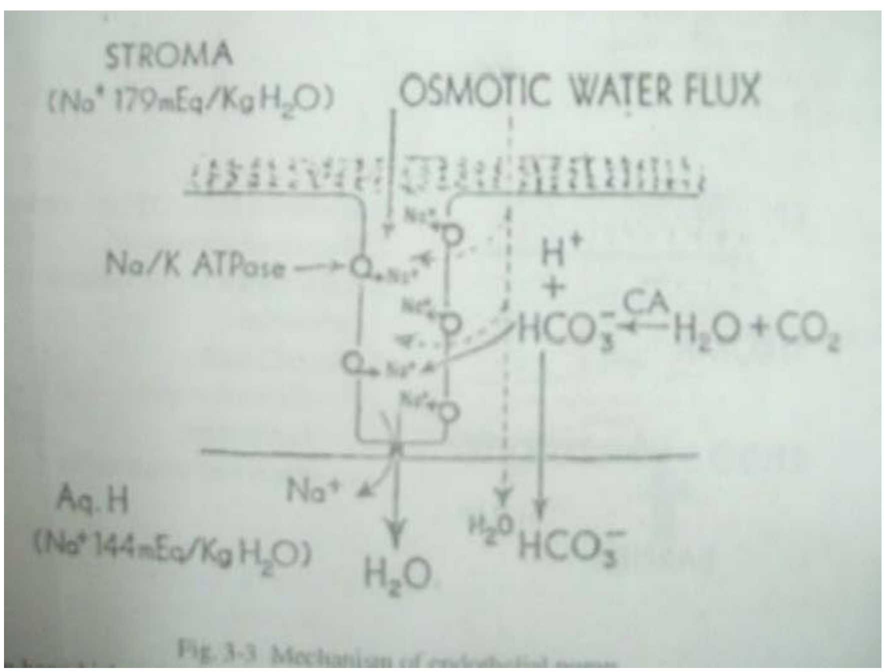
PAST AND PRESENT



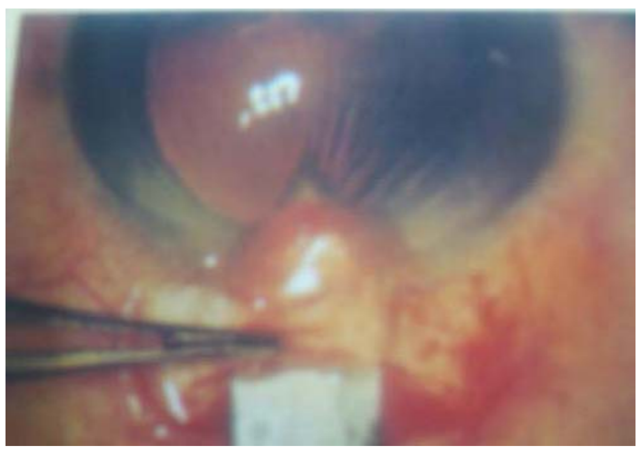
NORMAL CORNEAL ENDOTHELIUM

CORNEAL ENDOTHELIAL PUMP MECHANISM

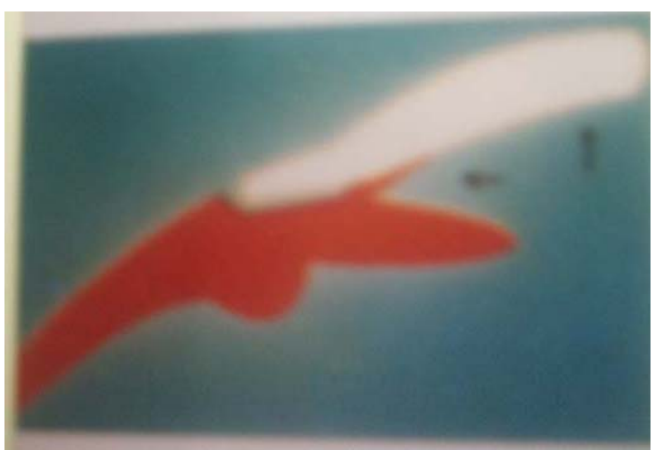


DISSECTION OF SCLERAL TUNNEL INTO CLEAR CORNEA

ENTRY WITH THE KERATOME



TUNNEL INCISION

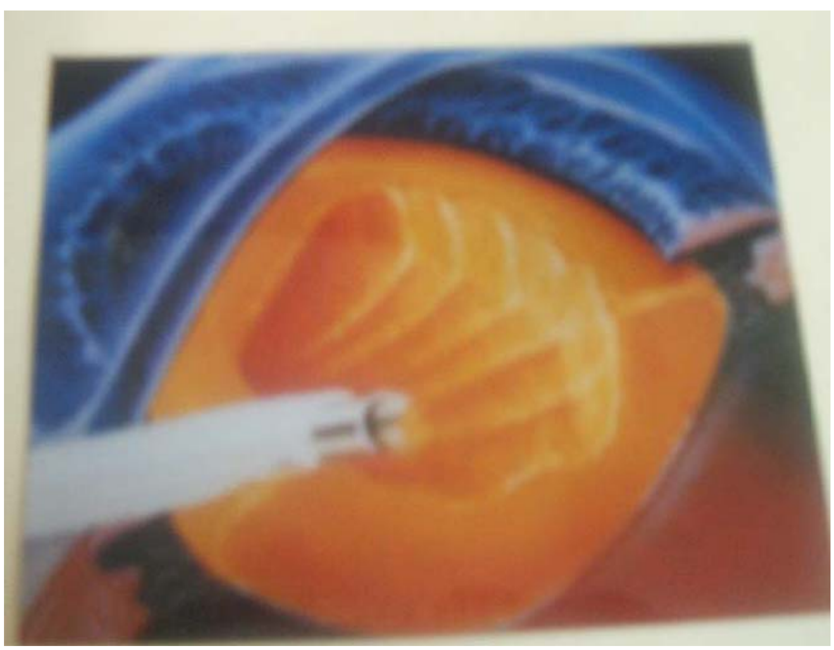


INITIATING CCC

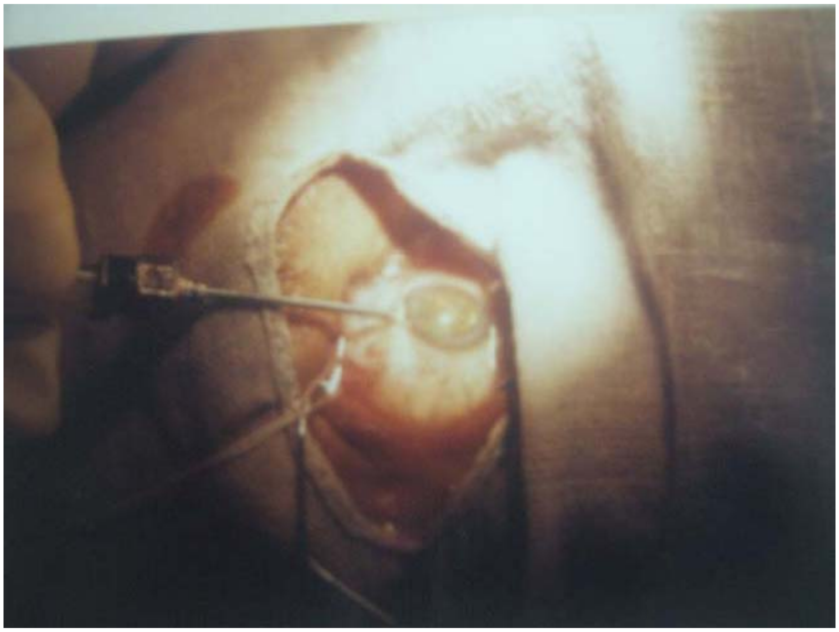
COMPLETION OF CCC

HYDRO DISSECTION

PHACO EMULSIFICATION PROCESS



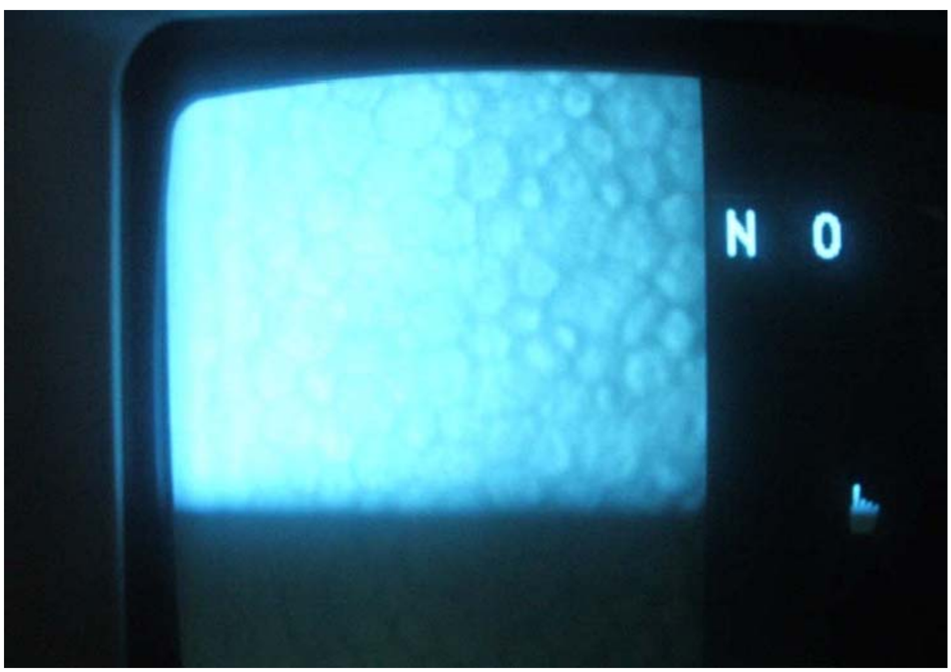
NUCLEUS DELIVERY WITH IRRIGATING VECTIS



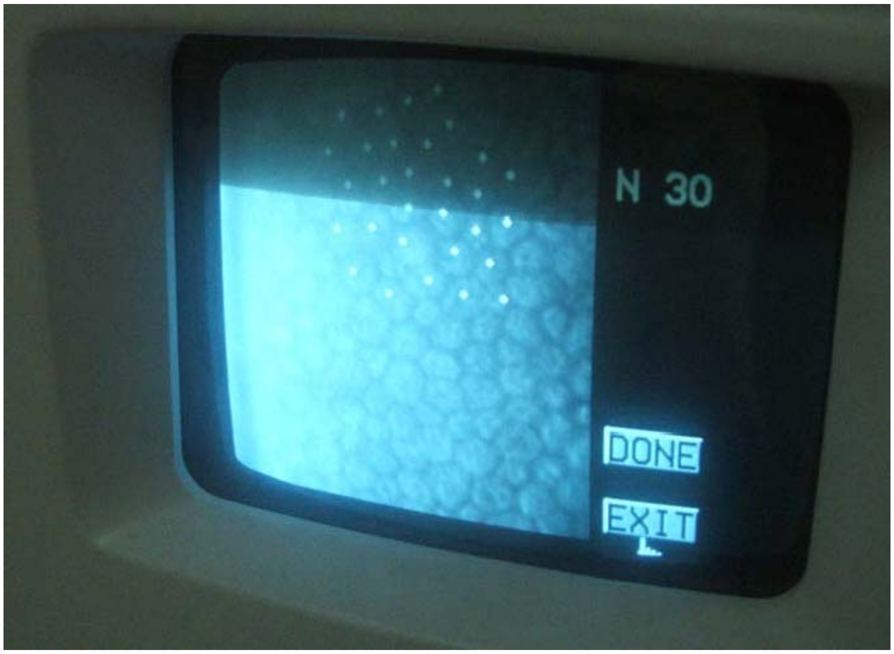
SCULPTING WITH PHACO PROBE

TOPCON SPECULAR MICROSCOPE

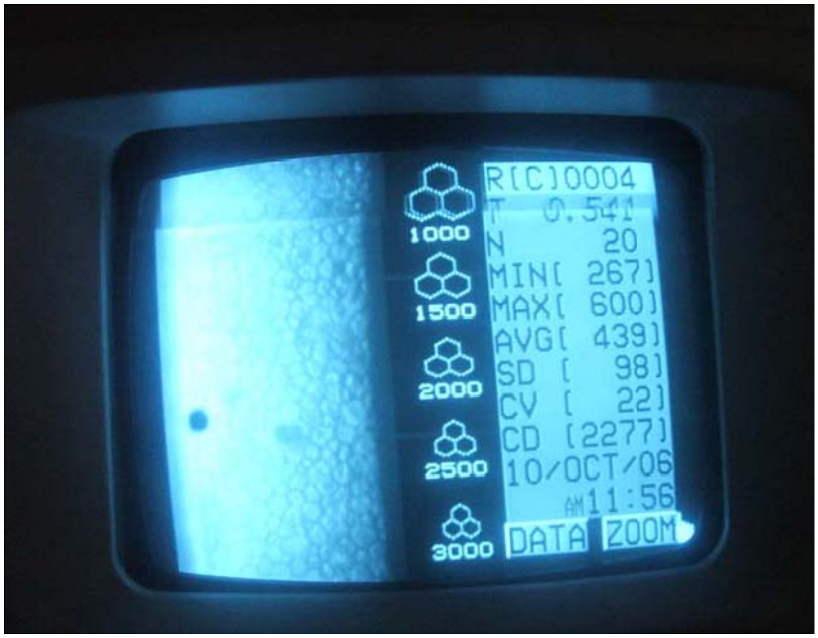
ENDOTHELIAL CELLS



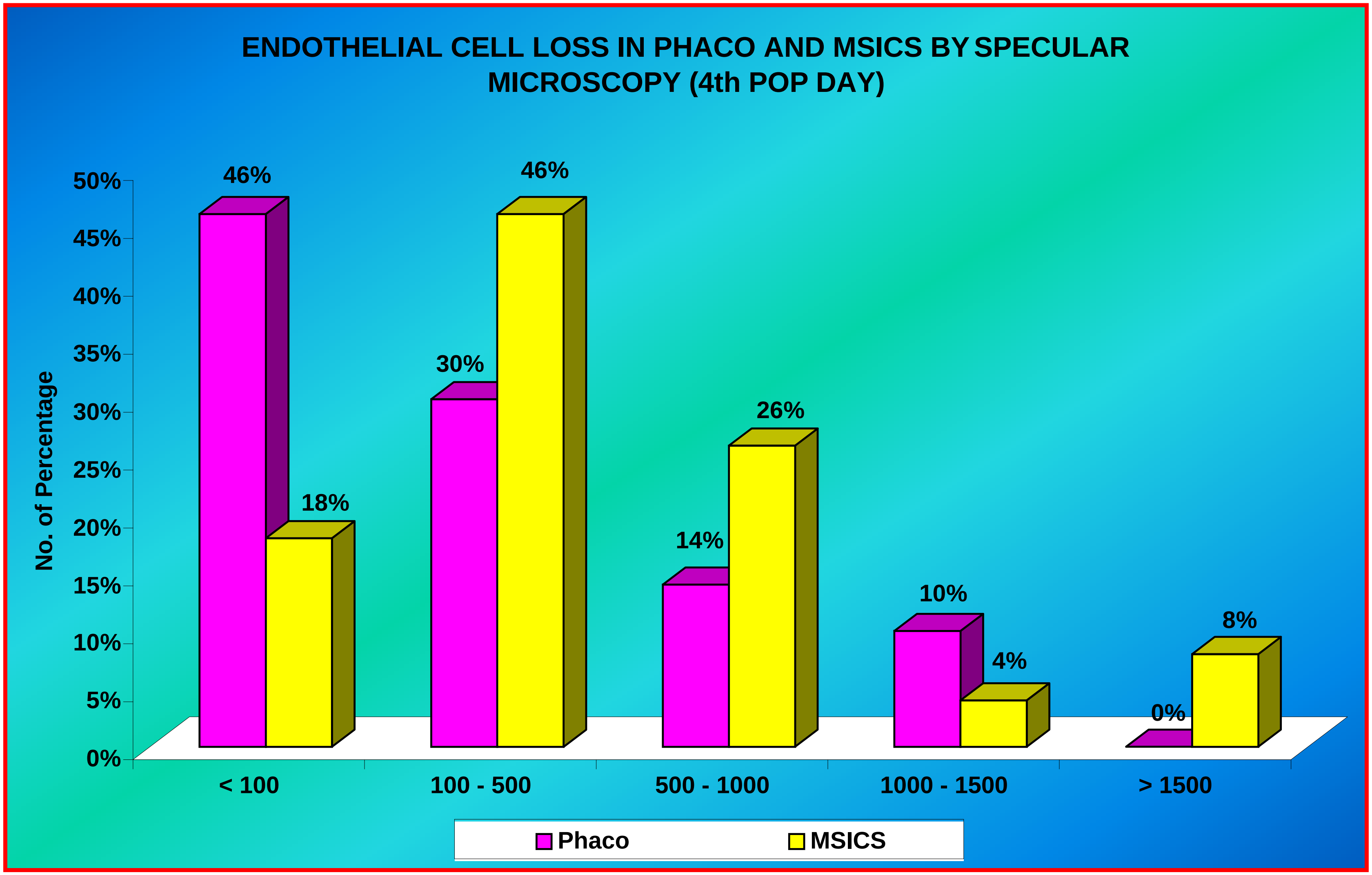
ENDOTHELIAL CELLS COUNT



PREOPERATIVE CELL COUNT



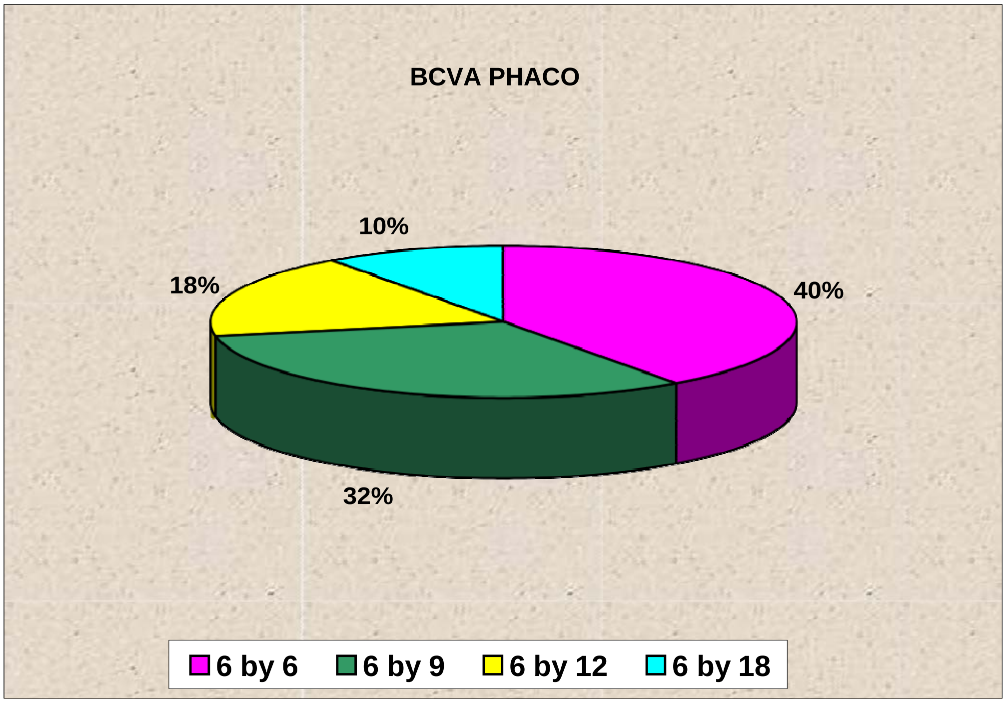
POSTOPERATIVE CELL COUNT

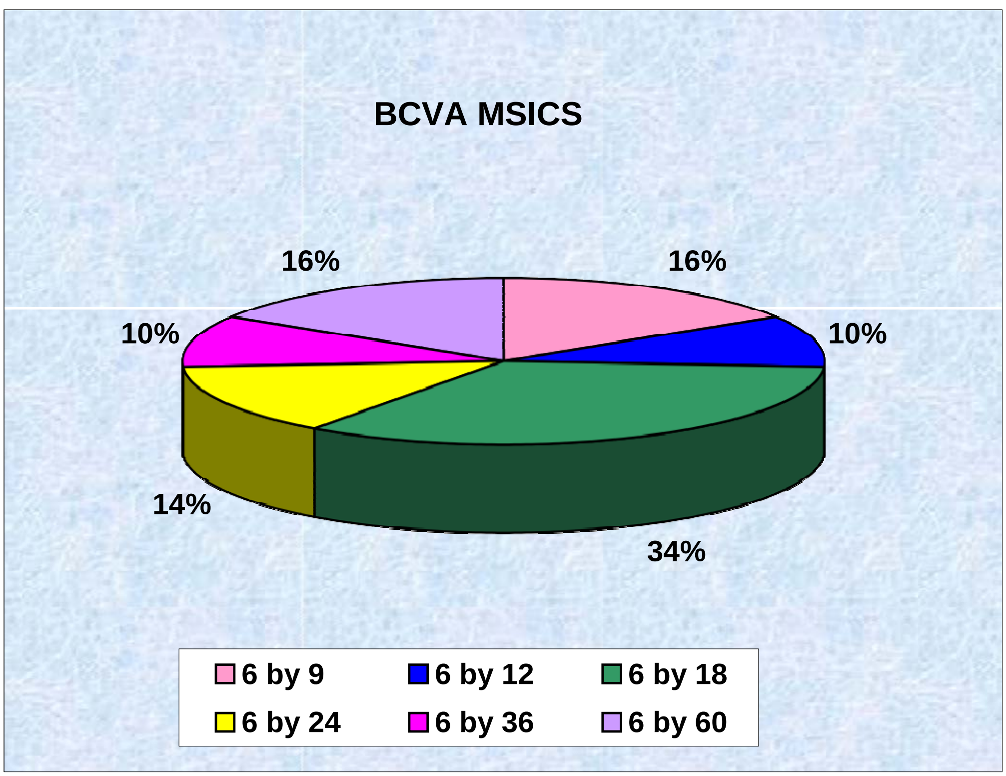

ENDOTHELIAL CELL LOSS IN PHACO AND MSICS BY SPECULAR MICROSCOPY (4th POP DAY)
No. of Percentage
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
46%
18%
30%
46%
14%
26%
10%
4%
0%
8%
< 100
100 - 500
500 - 1000
1000 - 1500
> 1500
Phaco
MSICS

6 by 6	40%
6 by 9	32%
6 by 12	18%
6 by 18	10%

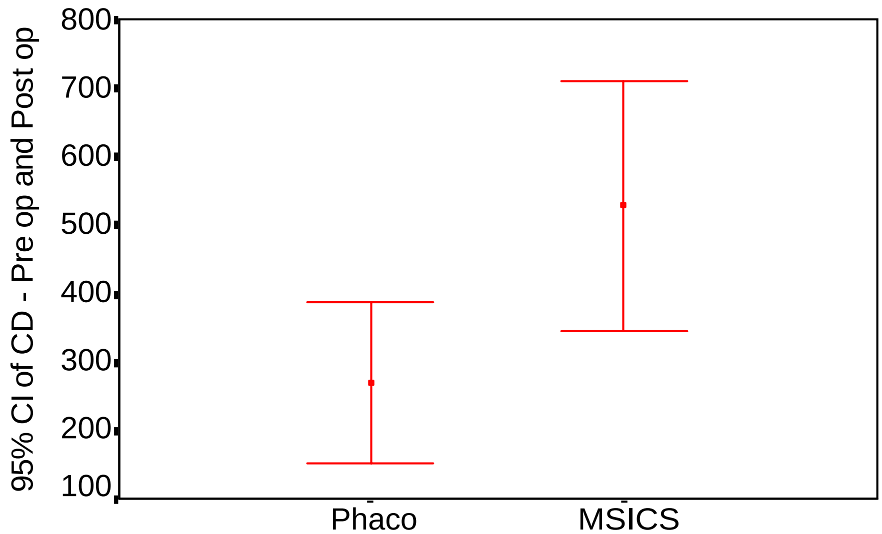
6 by 9	16%
6 by 12	10%
6 by 18	34%
6 by 24	14%
6 by 36	10%
6 by 60	16%

	Phaco	MSICS
< 100	46%	18%
100 - 500	30%	46%
500 - 1000	14%	26%
1000 - 150	10%	4%
> 1500	0%	8%

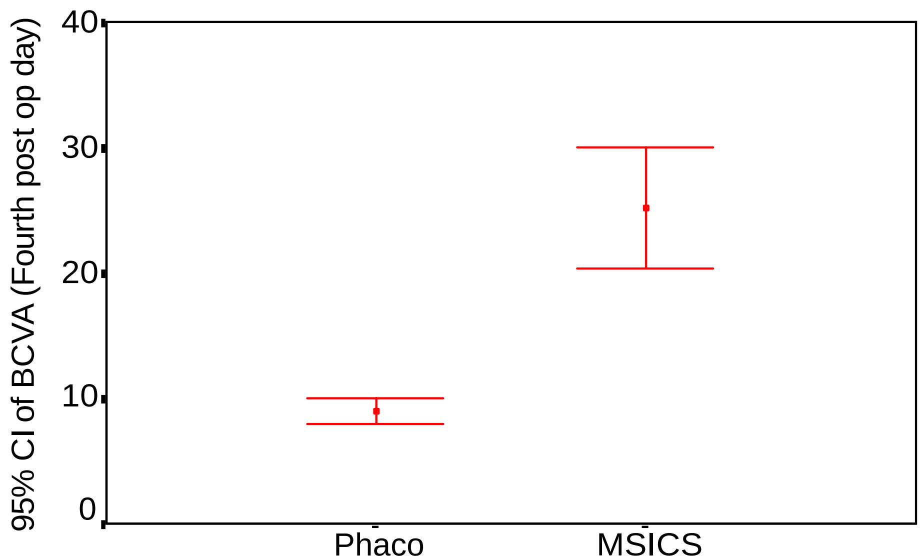

BCVA PHACO
10%
18%
40%
32%
6 by 6
6 by 9
6 by 12
6 by 18


BCVA MSICS
16%
16%
10%
10%
14%
34%
6 by 9
6 by 12
6 by 18
6 by 24
6 by 36
6 by 60

DIFFERENCE IN CELL DENSITY PRE-OP AND POST-OP (PHACO AND MANUAL SICS)



BEST CORRECTED VISUAL ACUITY (PHACO AND MANUAL SICS) FOURTH POP DAY



MASTER CHART
PHACO

Sl.No.	Name	Age	Sex	I.P. No.	UCVA Pre op.	CD Pre op.	Cataract grading	Per Op Complns.	Post op CD	BCVA (4th POP Day)
1.	Arjunan	50	M	402332	6/60	2171	NS II		2160	6/9
2.	Dhamayanthi	58	F	402634	6/60	2640	NS II		2540	6/9
3.	Dhamayanthi	58	F	402634	5/60	2812	NS II		2700	6/12
4.	Meenabai	60	F	402649	6/36	3229	NS I		2712	6/12
5.	Sulekha	45	F	403185	6/60	2581	NS I		2574	6/9
6.	Raghavan	53	M	404000	2/60	2138	NS II		2191	6/6
7.	Chandra	42	F	404229	6/60	2622	NS II		2399	6/9
8.	Ramakrishna	54	M	404487	5/60	2276	NS II	PCR	1065	6/18
9.	Ramakrishna	54	M	404487	6/60	2088	NS I		2151	6/6
10.	Mary	52	F	404483	6/60	2824	NS II		2548	6/9
11.	Poomani	55	F	404456	5/60	1848	NS I		1900	6/6
12.	Kumar	54	M	404507	6/60	2540	NS II		2027	6/9
13.	Alamelu	48	F	404734	1/60	2600	MC		3120	6/6
14.	Rani	58	F	404729	2/60	2722	NS II	Increase Aspiration	1821	6/12
15.	Ganesan	61	M	404978	3/60	2129	NS II		2242	6/6
16.	Saroja	51	F	405225	4/60	2530	NS I		2340	6/9
17.	Lakshmi	45	F	405854	6/60	2193	NS II		2249	6/6
18.	Navaneetham	70	F	406070	5/60	3368	NS III	Increase Phaco time	2564	6/18
19.	Vanaja	32	F	406241	6/36	3103	NS I		2841	6/9
20.	Kalaiselvi	48	F	406245	6/60	3391	NS I		2934	6/9
21.	Karunanidhi	54	M	406445	5/60	2855	NS II	Vitreous disturbance	2352	6/9
22.	Jaalo	59	M	406515	3/60	2190	NS III	PCR	1411	6/12
23.	Jaalo	59	M	406519	4/60	2180	NS II		1975	6/12
24.	Vijaya	30	F	406656	6/36	2917	NS I		2829	6/6
25.	Lakshmiammal	45	F	406849	5/60	3639	NS II	Increase irrigation	3166	6/9

Sl.No.	Name	Age	Sex	I.P. No.	UCVA Pre op.	CD Pre op.	Cataract grading	Per Op Complns.	Post op CD	BCVA (4th POP Day)
26.	Harikrishnan	64	M	406842	4/60	2172	NS II	PCR	1588	6/18
27.	Dhandapani	54	M	407031	6/60	2390	NS I		2277	6/6
28.	Kewsalya	50	F	396919	4/60	2899	NS II	PCR	1796	6/18
29.	Lalitha	45	F	397076	3/60	2190	NS II		2207	6/6
30.	Devagi	62	F	397234	5/60	2898	NS I	Increase phaco time	1607	6/12
31.	Andal	60	F	397483	6/60	3034	NS II		2859	6/9
32.	Shanmugam	64	M	397485	5/60	2404	NS II		2260	6/9
33.	Sivakumar	30	M	397755	6/36	2074	NS I		2113	6/6
34.	Dhanalakshmi	45	F	401474	5/60	3104	NS II	Increase irrigation	2008	6/12
35.	Thangavel	48	M	401737	6/60	2305	NS I		2312	6/6
36.	Loganayagi	50	F	401857	4/60	2913	NS I		3120	6/6
37.	Ramani	57	F	401801	6/60	2850	NS I		2858	6/6
38.	Andal	60	F	400294	5/60	3200	NS II		2850	6/12
39.	Devaiah	63	M	400297	6/60	2690	NS I		2683	6/6
40.	Suseela	54	F	400426	6/60	3224	NS II		3211	6/6
41.	Rajendran	60	M	400553	4/60	3751	MC		2614	6/18
42.	Sucochana	45	F	402055	4/60	2352	NS I		2411	6/6
43.	Amusu	49	F	402072	6/60	2379	NS I		2291	6/9
44.	Gangadharan	35	M	402336	6/60	2154	NS I		2255	6/6
45.	Padma	45	F	402367	6/60	3074	NS II	Increase phaco time	2253	6/12
46.	Matchakalathi	58	F	402340	5/60	2873	NS II		2924	6/6
47.	Parasuraman	52	M	406847	4/60	3122	NS II		2891	6/9
48.	Subramanian	59	M	403758	6/60	2152	NS I		2164	6/6
49.	Padma	45	F	402367	6/60	3074	NS II		3026	6/6
50.	Srinivasan	60	M	403252	5/60	3063	NS I		2913	6/9

MANUAL SICS

Sl.No.	Name	Age	Sex	I.P. No.	UCVA Pre op.	CD Pre op.	Cataract grading	Per Op Complns.	CD post op	BCVA (4th POP Day)
1.	Meenatchi	38	F	401372	4/60	3141	NS III	Premative entry	1567	6/36
2.	Durai pooshnam	69	M	401461	5/60	1983	NS II		1246	6/60
3.	Thangammal	65	F	401472	2/60	3212	MC		1731	6/60
4.	Parthasarathy	66	M	401477	2/60	2120	NS III		2309	6/18
5.	Rani	40	F	401508	4/60	2645	NS II		2324	6/18
6.	Perumal	40	M	401471	5/60	2856	NS III		2275	6/24
7.	Rosaiah	45	M	401739	6/60	3337	NS II		2881	6/18
8.	Kuppusamy	37	M	401850	6/60	2871	NS II		2767	6/9
9.	Lakshmi	50	F	401875	5/60	3112	NS III		2850	6/18
10.	Kulanthaithersa	60	F	402073	1/60	2050	MC		1815	6/36
11.	Lakshmi	50	F	401875	3/60	2732	NS III		2516	6/12
12.	Leela	55	F	402056	2/60	4139	NS III	PCR	742	6/60
13.	Leela	55	F	402056	2/60	2753	NS III		903	6/60
14.	Srinivasan	53	M	401160	5/60	3004	NS II		2878	6/12
15.	Ravanamma	55	F	402339	1/60	2050	MC		1815	6/36
16.	Murugesan	57	M	402652	2/60	2152	NS II		1825	6/18
17.	Krishnammal	68	F	402673	1/60	2166	NS III		2153	6/18
18.	Ravanamma	55	F	402865	1/60	2547	MC		2544	6/18
19.	Dilip	38	M	441624	6/60	2772	NS I		2815	6/9
20.	Kanthiamathi	47	F	39316	6/60	3387	NS II		3419	6/9
21.	Natarajan	51	M	403224	4/60	2447	NS III		2026	6/18
22.	Parthasarathy	66	M	403246	3/60	2808	NS II		1835	6/24
23.	Chandra	59	F	403245	1/60	3243	MC		2656	6/18
24.	Dhanalakshmi	57	F	403998	6/60	1874	NS II		1652	6/24
25.	Mohan	48	M	403978	5/60	2256	NS II		2303	6/9

Sl.No.	Name	Age	Sex	I.P. No.	UCVA Pre op.	CD Pre op.	Cataract grading	Per Op Complns.	CD post op	BCVA (4th POP Day)
26.	Annammal	54	F	404221	4/60	2290	NS II	Premature entry	1921	6/24
27.	Mary	52	F	404483	5/60	2546	NS II	PCR	534	6/60
28.	Srinivasan	67	M	404464	1/60	2977	NS III		2431	6/12
29.	Kathandapani	70	M	404723	1/60	1927	MC		1318	6/18
30.	Jagadambal	55	F	403445	4/60	2931	NS III		2145	6/24
31.	Sasikala	58	F	405006	5/60	2722	NS III	Premature entry	1821	6/18
32.	Kowsalya	70	F	405219	5/60	2331	NS II		2146	6/18
33.	Srinivasan	60	M	403252	1/60	3063	MC		1768	6/60
34.	Sozhimuthu	55	M	405234	5/60	3128	NS III		2545	6/24
35.	Sumathy	65	F	405602	1/60	2308	MC	Difficulty in delivery of nucleus	1904	6/18
36.	Adaihdamary	50	F	63043	5/60	2257	NS III		1756	6/18
37.	Savaiammal	70	F	405844	6/60	2791	NS II		2820	6/9
38.	Sahadaran	56	M	405866	5/60	2860	NS III		2377	6/12
39.	Sahadaran	56	M	405866	6/60	1883	NS II		1597	6/9
40.	Nagammal	67	F	400433	6/60	2131	NS II		2275	6/9
41.	Latha	35	F	356649	1/60	3342	MC		2935	6/18
42.	Penicillaja	65	M	406232	3/60	2929	NS III		1942	6/36
43.	Hubibullah	65	M	406518	3/60	2183	NS III		2240	6/9
44.	Shanyam	59	M	407011	5/60	2813	NS II		1962	6/24
45.	Subramanian	60	M	407024	2/60	2475	NS III		1940	6/60
46.	Rukumani	70	F	406017	3/60	2690	MC		2315	6/18
47.	Indrani	48	F	407027	3/60	2917	NS III		2707	6/36
48.	Shankar	50	M	405203	6/60	2735	NS II		2591	6/18
49.	Gapathyammal	58	F	401162	5/60	1605	NS III		1403	6/60
50.	Vijayalakshmi	40	F	63064	6/60	3298	NS II		3105	6/12